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(54) Diaphragm pump

(57) A pump diaphragm 5, e.g. for feeding a filter press, is reciprocated by a liquid column acted upon by a piston 35 reciprocated by a hydraulic motor 1 which is depressurised when a predetermined delivery pressure is reached. The volume of the liquid column is maintained by a control system incorporating a diaphragm sensor 51, 52.

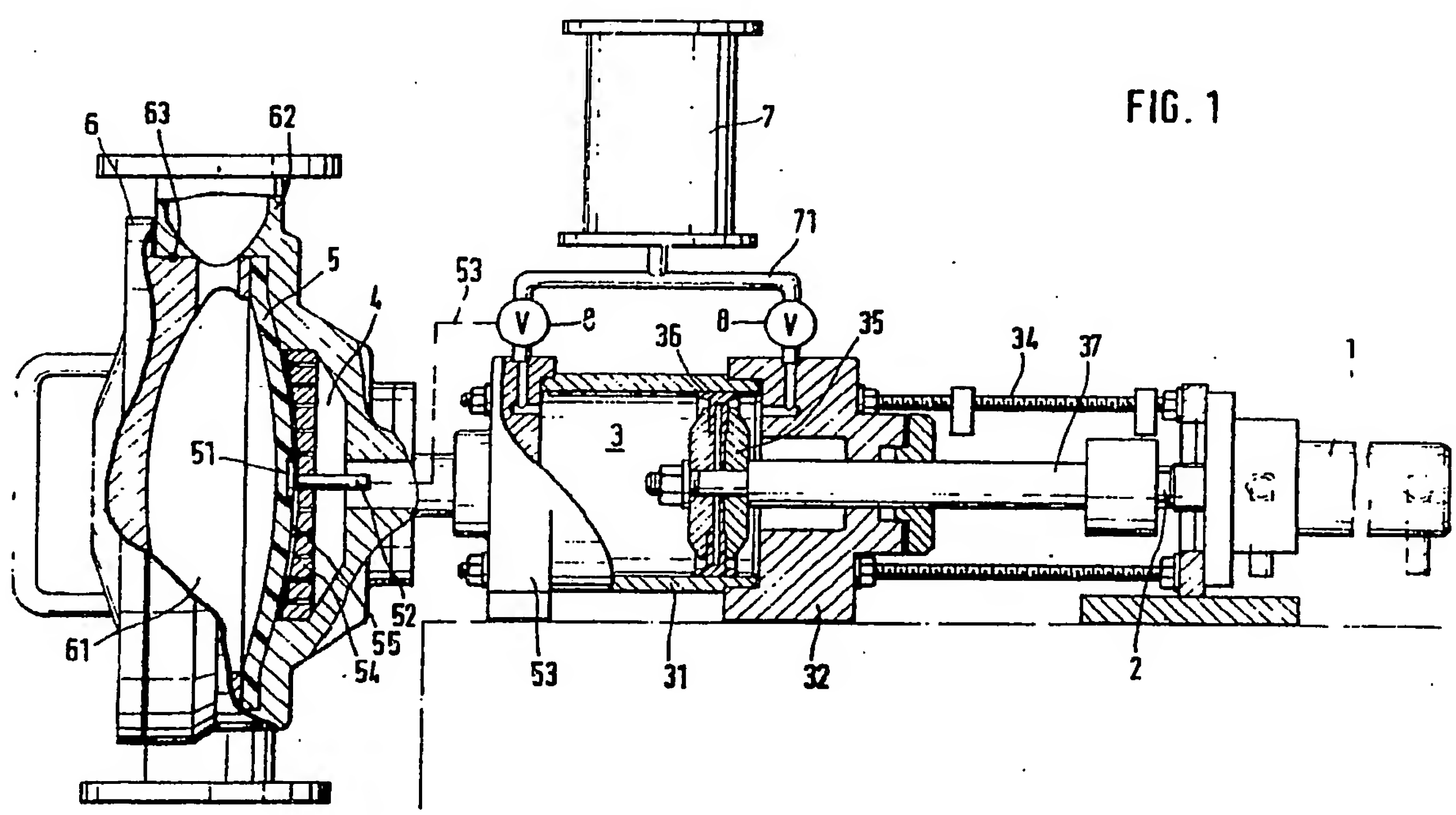

FIG. 1

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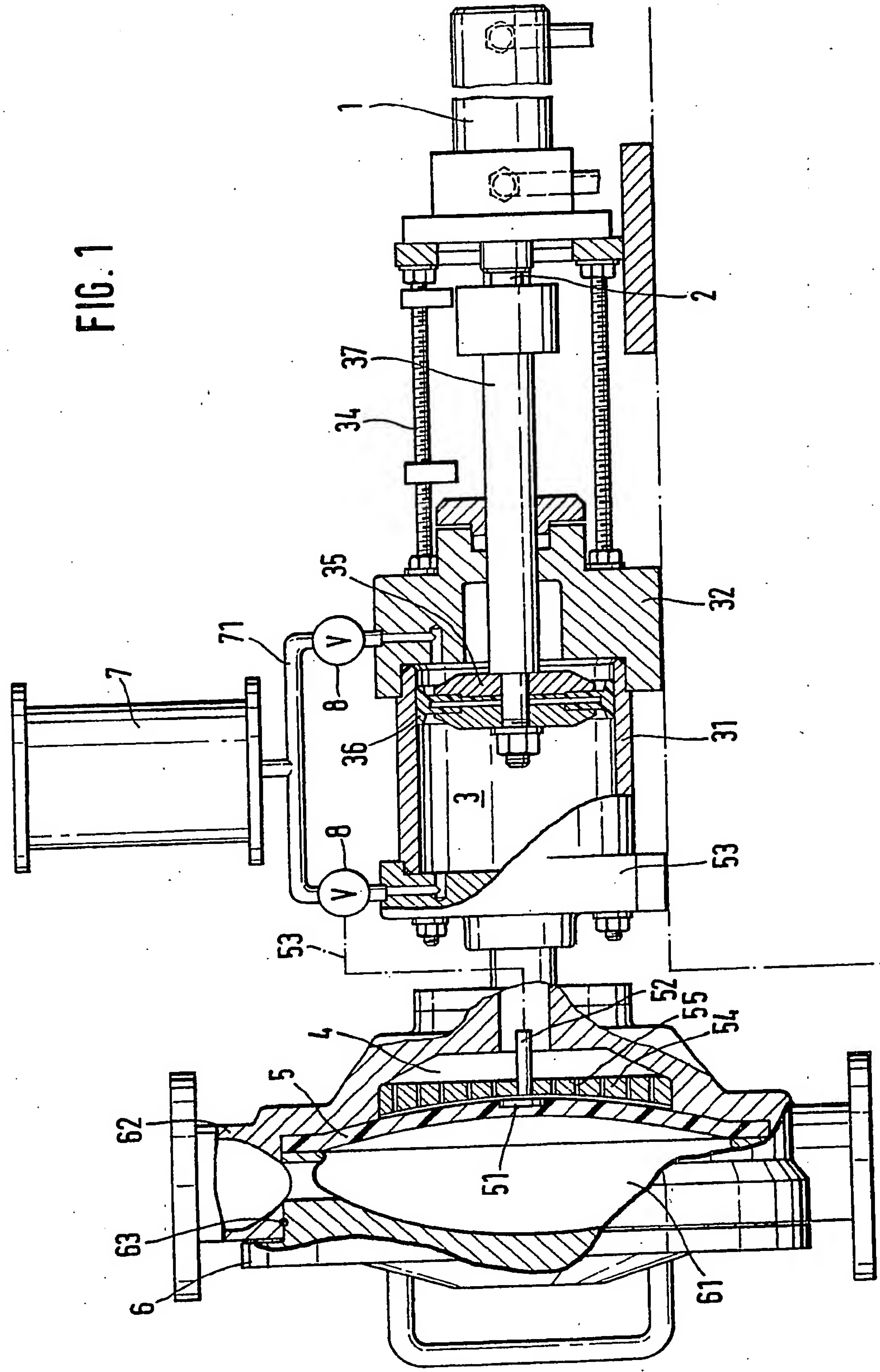
FIG. 1



the reciprocating movement of the working piston 35, on which pressure or mov ment-dependent end switches act (said switches being preferably provided on the outside of the piston rod 37) the diaphragm 5 is acted on in known manner, thus causing the chamber 61 to be fed; pressure and suction valves being associated with said chamber.

When a pre-determined maximal operating counterpressure is reached in the delivery line for the medium to be pumped, the hydraulic drive 1 is stopped, so that the hydraulic fluid in the working chamber 4 is made pressureless. The regulation of the hydraulic drive may be controlled by way of suitable valve arrangements by the operating pressure in the working chamber 4 or the delivery chamber 61 continuously down to zero quantity of the flow of pressure medium to the hydraulic drive 1. In order to control the hydraulic impacting of the working piston 35 in a dampened or retarded manner, a throttle control system may be provided—the control members of which may likewise by provided on the outside of the piston rod 37. By throttling the hydraulic drive before the end positions of the piston 35 are reached, the speed of the piston is braked. Similarly, a hydraulic driving cylinder with built-in end position damping may be used.

The working cylinder 3 comprises an interchangeable cylinder 31 sealed between the end flanges 32 and 33. These end flanges are tensioned against each other by means of tie-bars 34. The piston rod 37 of the working piston 35 is directly connected to the hydraulic piston 2 of the hydraulic cylinder 1 and the piston 35 is provided with interchangeable piston packings 36.

It is an indispensable condition for achieving perfect operation of the diaphragm that the working chamber 4 should be exactly filled with the hydraulic fluid. In order to compensate leakage losses, the chambers in front of and behind the working piston 35 communicate through control lines 71 with a re-induction after-suction container (tank) 7. Inserted in these control lines 71, the ends of which lead to insertion bores in the end flanges 32 and 33, are respective electro-magnetic valves 8 controlled electrically by means of the diaphragm 5. For this purpose, for example, the diaphragm 5 is provided with a fixed plate 51 forming a contactless end switch with a switch pin 52 provided with an insert 54 having bores 55 and fitted in the pump housing. The electrical control line from the switch pin 52 to the electro-magnetic valve 8 is indicated by the reference numeral 53. If, in the event of the diaphragm 5 swelling out in the absence of hydraulic fluid in the working chamber 4, and if such swelling becomes excessive, fluid flows out of the tank 7 through the opened corresponding valve 8 and into the chamber 4. The subsequent suction in the suction phase of the diaphragm 5 prev nts the working chamber 4 becoming overfilled with fluid.

The double-acting piston diaphragm shown in Fig. 2 is basically acted on, controlled and monitored in the same manner as in the embodiment shown in Fig. 1. The drive of double-acting working piston 13 is obtained by way of a hydraulic drive 12. Working chambers 16 and 19 and their associated diaphragms 22 and 23 are actuated alternately. Thus, in known manner, the medium to be delivered is pumped alternately through the respective suction valves 15 and 18 and through the respective pressure valves 17 and 20 into the common pressure line and, for instance, to a filter press.

The hydraulic cylinder 12 is differentially controlled with a ratio of piston surface area to piston rod surface area of, for example, 2:1. By this means the same forces and the same speeds are obtained in both delivery directions.

A pre-condition for perfect function is once again the exact filling of the working chambers 16 and 19 with pressure fluid. Contactless end switches 25 controlled by the diaphragms 22 and 23, give corresponding control instructions through the electric lead 24 to the electromagnetic valves 21 in the delivery lines from an aftersuction tank 14 to the working chambers 16 and 19.

The control, illustrated diagramatically in Fig. 2, as an example of the non-illustrated supply of pressure medium, a hydraulic pump, for example, shows that, after switching on the supply of pressure medium, a magnetic valve 10 receives current and effects the reverse control. The pressure medium supply is fed, through the magnetic valves 9 and 10, to the piston side of the hydraulic cylinder 12. The hydraulic fluid from the piston rod side also flows to the piston side through the valve 10. If the hydraulic cylinder 12 is extended, an end switch or a pressure switching device makes the magnetic valve 10 currentless and reverses it. The supply of pressure medium flows directly to the rod side of the cylinder 12. The hydraulic fluid from the piston side flows through the valve 10 to the supply of pressure medium or to the container thereof.

When the hydraulic cylinder 12 has moved into the starting position, an end switch or a pressure-operated switching device energises the magnetic valve and the hydraulic cylinder is extended again. When a predetermined maximal pressure has built-up in one of the diaphragm pumps, the idling valve 11 switches the hydraulic pump for the supply of pressure medium to pressureless circulation.

The hydraulic control may be adapted to the characteristic of a series-connected device, for example, a filter press, whilst, after reaching an adjustable operating counterpressure,

the hydraulic fluid in the particular working chamber is made pressureless.

With the use of a zero stroke pump for the supply of pressure medium, the hydraulic pump is controlled to the zero delivery quantity when the adjustable operating pressure is reached. The zero stroke pump adapts the required delivery quantity exactly by way of the number of strokes.

Basically, both the proposed hydraulic drive and the overpressure control may be used with all kinds of diaphragms, for example, also with so-called hose-piston diaphragm pumps.

CLAIMS

1. A diaphragm pump in which a reciprocating working piston acts on the diaphragm with the interposition of an initial supply of hydraulic fluid and in which, upon reaching a maximal operating counterpressure, the fluid in the working chamber between piston and diaphragm is made pressureless, characterised by a hydraulically driven working piston.

2. A diaphragm pump as claimed in claim 1, in which the hydraulic drive is controllable by way of the operating pressure in the working chamber or in the delivery chamber of the pump until the quantity of the delivery flow of the pressure medium is zero.

3. A diaphragm pump as claimed in claim 1, in which the working piston is directly connected to a hydraulic cylinder which is acted on by a controlled supply of pressure medium.

4. A diaphragm pump as claimed in claim 1, in which an after-suction container connected to the working cylinder for the compensation of losses of pressure fluid in the working chamber between working piston and diaphragm.

5. A diaphragm pump as claimed in claim 4, in which the inlet from the after-suction container to the working cylinder is regulated by an electro-magnetic valve which is controlled by the diaphragm, for example, by means of a contactless end switch.

6. A diaphragm pump as claimed in claim 1, in which pressure-dependent or way-dependent end switches are provided for limiting the stroke of the working piston.

7. A diaphragm pump as claimed in claim 1, in which there is provided a differentially controlled hydraulic cylinder.

8. A diaphragm pump as claimed in claim 1, in which the hydraulic impact of the working piston is dampened or retarded by a way-dependent throttle control or by end position damping in the cylinder.

9. A diaphragm pump as claimed in claim 1, in which the working cylinder comprises a hollow cylinder interchangeably inserted with sealing action between two terminal flanges

10. A diaphragm pump as claimed in claim 8, in which control members for limiting the movement and the impacting of the piston are provided on the outer piston rod of the working piston.

11. A diaphragm pump as claimed in claim 1, in which an O-ring is inserted between a diaphragm cover and pump housing.

12. A diaphragm pump constructed and arranged to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

CLAIMS (27 Sep 1978)

12. A diaphragm pump as claimed in claim 2, in which the hydraulic drive is controllable by way of a zero pressure pump.

13. A diaphragm pump constructed and arranged to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

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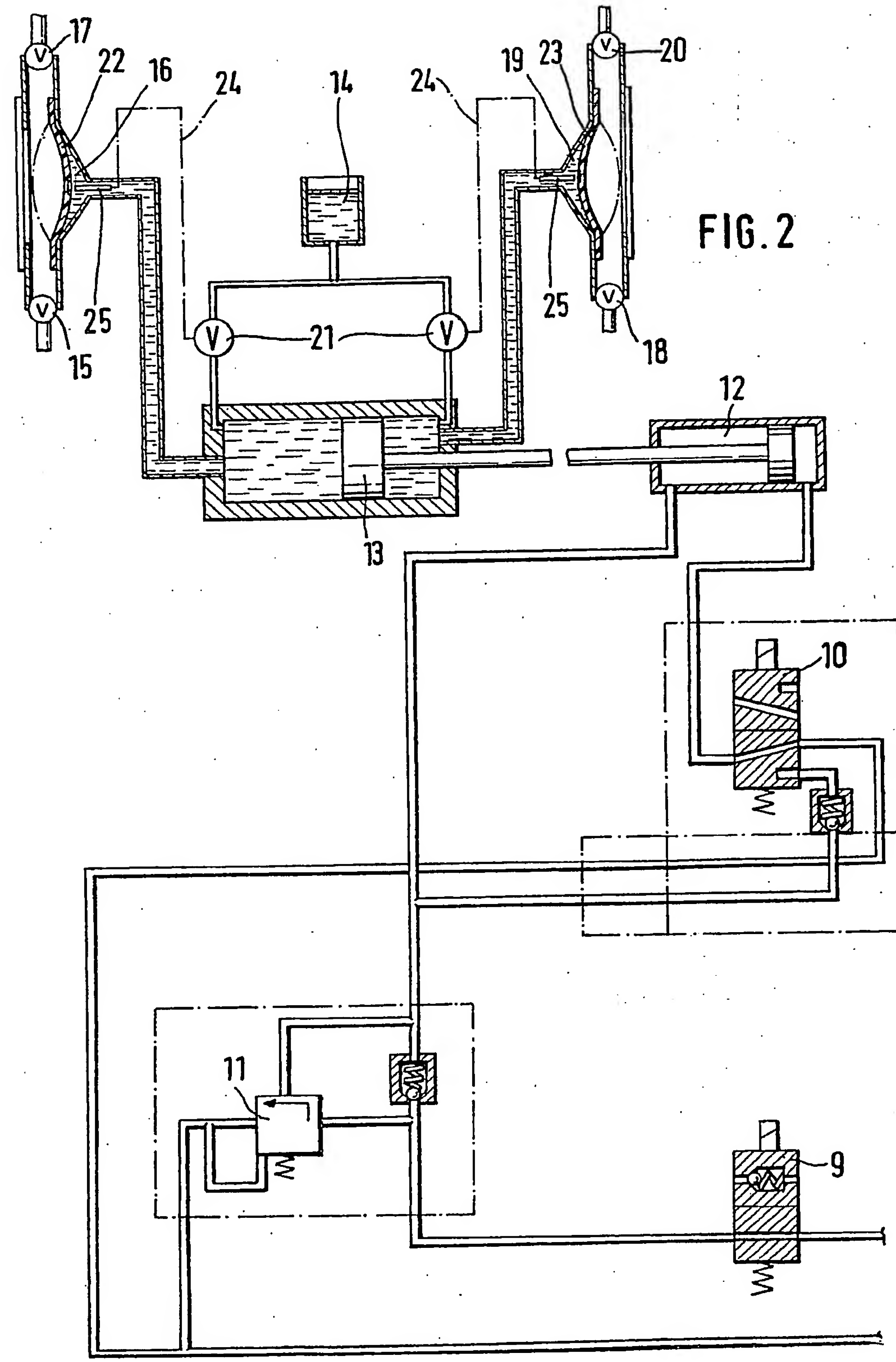

FIG. 2

SPECIFICATION

A diaphragm pump

The present invention relates to a diaphragm pump in which a reciprocating working piston acts on the diaphragm with the interposition of an initial supply of hydraulic fluid and in which, upon reaching a maximal operating counterpressure, the hydraulic fluid in the working chamber between piston and diaphragm is made pressureless. One or two diaphragms may be acted on by one piston.

Such piston diaphragm pumps are particularly suitable for the delivery of abrasive and highly viscous sludges having a high solid concentration and are used, for example, for feeding filter presses.

Diaphragm pumps are known in which the slowly running piston is driven by means of an encapsulated transmission gear running in an oil-bath and in which the actual drive is an electric motor. The initial amount of hydraulic fluid, for example water or oil, is controlled by means of adjustable valves. Leakage losses are automatically compensated. The pumps are usually adjusted to a maximal operating counterpressure in the delivery line. When this pressure is reached, the initial amount of hydraulic fluid is reversed and is thus adjusted, pressureless in front of the diaphragm in the working chamber.

The disadvantages of this prior art construction are the expensive and voluminous amount of construction involved in the driving gear and also the complicated reversing and pressure quantity regulation of the initial amoűnt of hydraulic fluid.

The object of the present invention is to make the drive, the design and the control of a diaphragm pump of the above mentioned type more favourable, particularly with reference to its overall volume.

This object of the present invention is achieved in a diaphragm pump characterised by an hydraulically driven working piston which is controllable by the operating pressure in the working chamber or in the delivery chamber down to zero quantity of the delivered flow of pressure medium. The reversal from suction to pressure stroke is preferably effected by means of a contactless end switch on the suction side of the diaphragm.

At the same time, the working piston is directly connected to the hydraulic cylinder on which a controlled supply of pressure medium can act. Dampened or retarded action on the working piston can be achieved by a way-dependent throttle control in order to avoid excessive stressing of th components, particulary the diaphragm, during high piston speeds.

The particular exact filling of the working chamber in front of the diaphragm with the importance. For this reason the working cylinder is connected, in accordance with the present invention, to an after-suction container (re-admission chamber) for the compensation of pressure fluid losses. According to a preferred embodiment of the present invention, the inlets from the after-suction container to the chambers in front of and behind the piston in the working chamber are regulated by an electromagnetic valve which is controlled by way of the diaphragm. This control is preferably effected on the suction side of the diaphragm by means of a contactless end switch. This avoids any excess filling of the working chamber with the initial supply of hydraulic fluid.

The present invention also includes the proposal to construct the working cylinder from a hollow cylinder interchangeably inserted with a sealing action between two end flanges—said flanges being tensioned against each other by draw-bars. In this manner, the cylinders and pistons when subjected to wear can be replaced in a simple manner.

The diaphragm pump of the present invention needs to be driven only by a relatively small hydraulic cylinder acted on by a supply of pressure medium. The pressure-dependent control of the drive can be achieved in a particularly simple manner since the delivery flow can be directly controlled dependently on pressure. Excess pressure valves or bypass controls on the pump are unnecessary. The same delivery outputs with much smaller units of construction are obtained by the pump of the present invention compared with conventional known diaphragm piston pumps. A suitable method of controlling the hydraulic drive renders possible a simple construction of a system with different outputs and the way-dependent retarded or dampened action on the working piston.

The present invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a basic illustration comprising a longitudinal section through a piston diaphragm pump of a single-acting type; and

Figure 2 is a circuit diagram of the control of a double-acting type pump.

Reference will first be made to Fig. 1. In a working cylinder 3 of a piston diaphragm pump of single acting type having a pump housing 6, a working piston 35 is driven via its piston rod 37 by a hydraulic cylinder 1 which is directly connected to said piston 35. This hydraulic cylinder 1 is acted on by a supply of pressure medium (not shown).

A working chamber 4 between the piston 35 and the diaphragm 5 which is held in pump housing 62 with an inserted O-ring 63 by diaphragm cover 6, is provided with an initial supply of hydraulic fluid, either water or oil. The diaphragm separates the working